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THE BLACK ROT OF THE GRAPE.

BY CHAS. R. CARPENTER, M. D.

Of the diseases of the grape, probably none is more destructive than that which is known as the Black Rot, where it occurs in a pronounced form. And in this State, where it occurs in its most destructive form, it is important to viticulturists that they understand the causes of the disease, the conditions under which those causes become operative, and the intelligent method of treatment.

After the investigations of Scribner, Trelease, Ellis, and others in this country, and Viala and Ravaz in France, it would seem almost superfluous to discuss the question whether the rot is a parasitic or a trophic disease. Nevertheless it is being discussed, and good arguments being adduced on both sides; both good, for the reason that both are correct.

No profound result is accomplished in nature by the action of a single isolated cause; and it is no more to be expected here than elsewhere. To argue that the *phoma uvicola*, or as its mature form is now called, the *physalospora Bidwellii*, does not operate as a cause in this disease, is to invite the suspicion of a limited knowledge of the character and natural history of this fungus. To argue that the trophic condition of the vine does not operate also as a cause, is to argue that a man who is starved, whose blood is vitiated from the absence of proper food, whose tissues are imperfectly sustained, and whose entire functional organism is impaired, is not more susceptible to the advent of disease than a man who is strong, well-nourished and healthy at the time of exposure. The hard and fast rules of common sense are to be applied to the physiology and pathology of vegetable organisms in the same manner as they are applied to the physiology and pathology of animal organisms.

To one accustomed to study the causes of things it seems almost inevitable that an imperfect nutrition of the individual, whether animal or vegetable, and a correspondingly low condition of vitality, should invite disease. Disease may be defined in general terms as any interference with the natural process of waste and repair in an organized body, and the mechanical results of that interference. If nutrition is withheld entirely, dissolution is the result. If it is withheld partially, dissolution is favored, because the conditions are furnished which are necessary for the operation of those causes which produce an entire interruption of the process of waste and repair.

We may have an interference with the process of waste and repair which does not affect the entire organism. It may affect a very small portion of the organism, and hence we have hundreds of trivial diseases which produce no tendency to dissolution whatever in the general organism. The black rot is a grave disease, tending to direct and immediate dissolution in that part of the organism affected, the fruit. And hence any condition which favors dissolution favors the operation of any cause that is capable of producing the disease. Deficient nutrition manifestly favors dissolution; it therefore operates as a predisposing cause of the black rot. But deficient nutrition operates as a cause of disease in general, because it is a general condition. It predisposes to any and all diseases, systemic as well as local.

What then determines the advent in one case of the black rot, in another the grape mildew, in another the powdery mildew, and so on through the whole list of the grape diseases?

Some would argue that a deficiency in the supply of some particular element or elements might give character to the different diseases, and that the three species of fungus that occur so evidently in the three diseases mentioned are simply three accidental growths; that they do not act as a cause, but are simply a result.

If they are a result in any sense, they are a necessary result; because they occur invariably.

Not a single specimen of the black rot in any stage has ever been placed under a microscope without revealing the presence of the characteristic fungus, distinctly correlated to the stage of decay found in the specimen. If the fungus was only a possible result, specimens would inevitably be found among the thousands examined, in which the fungus was absent. If it is not a result, it must be a cause.

It is a cause.

It is the exciting cause, and no matter how much the vine may be predisposed to the disease, without the action of the exciting cause the rot will not take place.

The history of the advent of the disease into France is of itself sufficient to prove that some peculiar and special condition is necessary as an exciting cause to produce the rot.

For hundreds of years France had been one of the greatest vine-growing countries in the world. She had furnished fruit for every market in the world, and her wines were to be found in every city in the world. The vineyards of France were a national pride. The vines were tended, pruned, trellised, and fertilized with the greatest care. Diseases of many kinds showed themselves, but were nearly always controlled by ordinary measures; and never was the black rot known in France until the year 1885, two years previous to the present writing.

The same treatment of the vines has been pursued since; the same method of pruning, trellising and fertilizing has been used, but the spirit of Death stalks on through the luxuriant vineyards, touching with his deadly finger berry after berry, cluster after cluster, and they die.

The fruit forms and grows beautifully up to a certain size, giving promise of a magnificent yield. No prospect could be finer. Suddenly a minute spot appears here and there upon the surface of a berry; a whitish or yellowish spot which may be elevated like a blister on the human skin. Rapidly a dark areola forms around it; then a system of concentric dark rings with lighter spaces between which gradually give way to the uniform dark-brown color of the disease. Other spots appear and pursue a like course; then others, and still others; all enlarging rapidly until, in an amazingly short space of time, the entire vineyard is studded with rapidly darkening berries. Whole bunches are blighted; but each individual berry is made the object of a separate attack. Not a leaf, not a stem, not a petiole is affected primarily; only the beautifully clustering fruit which looked so fair, and promised so fairly.

It is a striking phenomenon, and one which almost unconsciously prompts the question: "What can be the cause of all this untimely death and decay?"

Not until the searching eye of the microscope was turned upon the object of our study were we able to answer satisfactorily this question. It would seem that the seeds of death had been sown broadcast by an invisible hand; and, indeed, this is about what occurs, as we shall see.

As early as 1861 the *phoma uvicola* was observed and described by Dr. Englemann, but its natural history is so complex that all the years intervening between that time and the present have contributed very little to our knowledge of it, until the last few years, when Viala and Ravaz, Scribner, Trelease and others have again taken up the subject.

At any time after the whitish spot has declared the presence of the disease in the berry, a cross-section through the affected portion will show the threadlike hyphæ of a mycelium burrowing between and through the cells of the grape tissue. In the early stage of the disease the growth of the mycelium is confined to the tissue underlying the epidermis, but as the disease progresses it encroaches more and more

upon the body of the tissues, decomposing and sucking up the cell contents for its own nourishment, and hence breaking down those tissues by destroying the trophic functions.

The progress and extent of the rot, then, in each berry, is in direct correlation with the growth and vigor of the mycelium; and when the growth of the mycelium for any reason becomes checked, the progress of the rot is checked at the same time. In passing through a vineyard one may find berries in which the rot has been checked in all stages, from a minute speck to a spot equal to one eighth or a quarter of the berry. In such cases the berry goes on to maturity as though nothing had happened, except that it carries this dark scar upon its cheek. Even when one-half or more of the berry has rotted, the remaining portion may go on to maturity, but the nutrition is so impaired that it frequently shrivels up, though the decay proceed no farther.

Now a proposition which we wish to submit is, that fructification of the fungus checks the growth of the mycelium; hence checks the progress of the rot in that particular berry. Conversely, that checking the growth of the mycelium hastens fructification; from the fact that it draws the attention of nature to the necessity of accomplishing this crowning act before it is too late.

Observation bears out this proposition.

All observers agree that fructification of this fungus takes place in four forms; but no single observer has ever been able to identify all four of the forms. Scribner found two of them only in his own researches. Mr. Erwin Smith is his authority for the third; and the fourth was observed by him in a specimen furnished him by Mr. Ellis.

In examining a large number of specimens, the writer was able to observe only two of the forms—the same described by Mr. Scribner.

When the mycelium is checked in its vegetative career by the stimulus of nature to prepare for the crowning act of its life, it bends its energies to the production and growth of little perithecia or capsules for the protection of the spores which are destined to occupy them.

Two forms of perithecia are now produced directly from the mycelium, immediately beneath the epidermis, bulging it up in minute elevations which give to the surface a pimpled appearance. Of the two forms, the *pycnidia* are the larger, more scattering, and earlier in appearance; the *spermagonia* the smaller, more closely aggregated, and by far the more numerous. The spores contained in the pycnidia are called stylospores; because they are borne upon little styles seated upon the base of the capsule. They are extruded through the raised epidermis by the flow of the viscid contents of the capsule through any rupture in its surface. The spermagonia contain minute spores called *spermatia*, because there is at least a probability that they are the male element of reproduction. If this be the case, analogy and the existing conditions suggest that the stylospore of the pycnidia are the female element.

Scribner says: "Not infrequently the first evidence of the disease is the sudden appearance of one or more circular, slightly-depressed spots of a bluish-black color, in the center of which there soon appear a few of the little pimples or pustules referred to. These spots increase in size, the pimples in number, and ere long the berry exhibits the usual black and shriveled appearance."

The observations of the writer do not corroborate this statement. Wherever these blue spots were found, and they were not infrequent, they were never observed to grow larger, although the number of pimples might increase. The appearance of the spermagonia upon the surface in the shape of pimples seemed to be a signal for the advance of the rot to cease, and the portion which had already rotted to become bluish black and shriveled. The pycnidia may occur earlier on the smooth brown

surface which characterizes the disease in its active stage; but we have not observed the affected portion of the berry to become black or shriveled until the vegetative career of the mycelium is apparently checked. Then the spermatogonia make their appearance on the surface, always at or near the point where the disease began, and then the part immediately around and under them begins to grow black and shriveled.

These two forms of fructification, in all probability, serve for the immediate distribution of the fungus during the summer season. And from the fact that the conidial, or third form, is only observed late in the season upon old diseased berries, and the fourth form in the spring, it is probable that they are the means by which the species is preserved from one season to another; in other words, that they furnish the winter or resting spores.

The *conidia* are little hair-like projections, which under favorable conditions grow up from the surface of pycnidia, from which the contents are being extruded. They are erect, and bear upon their distal end a few scattering spores.

The fourth or supposed mature form is produced in the spring — about the month of May, it is said — by the action of warmth and moisture upon old diseased berries. A fruiting body is formed similar in every way to the first two, except that it contains little ellipsoid bodies called asci, which are fastened by one end to the bottom of the capsule. These in turn contain a certain number of spores or germinating bodies. This form is called the *sporidium*.

The conditions necessary, then, for the advent of the black rot, are a lowered vitality from imperfect nutrition, whether caused by exhaustion of the soil, by overbearing, or both; and the presence of the germinating bodies in some form of the *physalospora Bidwellii*.

These conditions being present, how are they to be dealt with by the viticulturist?

Build up the strength of your vines with plant foods; fertilize, in other words, and replenish the elements that have been exhausted from the soil by the constant growth and bearing of the vines.

husband the strength of the vines also by cutting back; by trimming off the old wood; and by preventing heavy crops.

Destroy every vestige of the diseased fruit which may have remained over from the previous season; destroy it by fire. And as a therapeutic measure, when the grapes have attained a size at which they are from the surrounding conditions liable to an attack, or when the attack has been precipitated, use sulphurous acid gas as a germicide.

Use it in the following manner: Take a stick of roll sulphur and place it end to end with a wooden stick of convenient length. Roll them both in a piece of thick coarse cloth, such as a gunny sack, and light the sulphur. The cloth will cause it to burn slowly like a torch.

Take the torch in one hand and a watering-pot in the other. Sprinkle the fruit slightly, and then fumigate. The water absorbs more or less of the gas, and holds it *in situ* for a greater length of time than it would otherwise remain.

Sulphurous acid gas is one of the most powerful germicides known; sulphur is cheap, and the method effective. The operator can walk along his trellises and in a very short time fumigate to a sufficient extent a large vineyard.

So far as is known, Dr. Langworthy, of Leavenworth, is the originator of this method, and to him is due the credit of an important advance in the treatment of this disease, as well as the thanks of viticulturists.